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January 23, 2002

Ms. Magalie Salas, Secretary
Federal Communications Commission
445 12th Street SW
Washington DC 20554

**Re: ET Docket No. 98-153 -- Revision of Part 15 of the Commission's Rules Regarding
Ultra-Wideband Transmission Systems
*Ex Parte Communication***

Dear Ms. Salas:

Pursuant to Section 1.1206(a)(1) of the Commission's Rules, on behalf of XtremeSpectrum, Inc., I am electronically filing this written ex parte communication in the above-referenced proceeding.¹

XtremeSpectrum responds to the filing by Qualcomm Inc. of January 11, 2002.

Important: The attached "XtremeSpectrum, Inc. Technical Response to Ex Parte Filing of Qualcomm Inc. Dated January 11, 2002" is not an appendix, but is an integral part of this filing.

**ULTRA-WIDEBAND WILL NOT CAUSE INTERFERENCE TO
GPS-BASED E911.**

Qualcomm alleges that ultra-wideband (UWB) will interfere with GPS-based E911 handsets out to 75 meters.

¹ XtremeSpectrum, with 67 employees, conducts research in ultra-wideband communications systems as its sole business. XtremeSpectrum intends to become a ultra-wideband communications manufacturer once the Commission authorizes certification of such systems. XtremeSpectrum takes no position on ultra-wideband radar applications.

This conclusion is incorrect. As we show below, the minuscule levels of UWB emissions levels -- well under a billionth of a watt, in the GPS band -- extend over a few tens of centimeters at most, and are completely safe for E911.

At the heart of Qualcomm's analysis are three wrong assumptions:

1. ***Unrealistically high emissions levels.*** Qualcomm assumed UWB emissions in the GPS band at Part 15 levels. *Neither the NPRM nor any party supports those levels.* XtremeSpectrum has proposed levels of 21 dB below Part 15 for non-peer-to-peer communications, and 34 dB below Part 15 for peer-to-peer communications.² Just substituting these numbers into Qualcomm's analysis brings the interference distances down by 98 percent or more.
2. ***Unreasonable environment.*** Qualcomm assumed the UWB emitter and GPS-equipped handset are alone in the universe, with no other sources of radio interference. But the typical home or office has dozens of radio-frequency emitters. *In the GPS band, UWB will operate at far lower emissions levels than any other device in the FCC rules.* The handset's performance will be limited not by UWB, but by the myriad of other sources of radio noise.
3. ***Unreasonable propagation.*** Qualcomm assumed that radio waves can propagate indoors for 75 meters as they would in outer space, without any obstacles or reflections. In fact, ordinary walls and furniture severely attenuate UWB signals.

Correcting just the first two of these assumptions brings down the range of potential interference to only a few tens of centimeters or less, and UWB ceases to be a factor in E911 performance.

* * * *

² Our proposed rules are attached as an appendix.

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If there are questions about this submission, please call me at the number above.

Respectfully submitted,

Mitchell Lazarus
Counsel for XtremeSpectrum, Inc.

cc: Chairman Michael Powell
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***XtremeSpectrum, Inc. Technical Response
to Ex Parte Filing of Qualcomm Inc.
Dated January 11, 2002***

I. Introduction

In a recent submission, Qualcomm reports on recent tests designed to measure the impact of UWB device emissions on GPS-enabled wireless phones. Such phones have been developed by Qualcomm to provide E-911 location services for wireless phones. Qualcomm concludes that any UWB emissions in the GPS band will significantly raise the noise floor of GPS-enabled wireless phones and will render such GPS devices useless.

Qualcomm's conclusions are incorrect, as a technical matter, because certain fundamental assumptions underlying its analysis are invalid.

Specifically, Qualcomm assumed:

1. UWB emissions at 21 to 34 dB above proposed emission limits (*i.e.*, Qualcomm assumed existing Part 15 levels, which no party supports) ¹.
2. No real-world propagation effects such as multipath and obstacles, but instead unimpeded propagation of indoor UWB signals to indoor GPS receivers, as though through outer space, even at ranges of 75 meters or more ².
3. No other sources of real-world radio-frequency interference (RFI) ³.

When these assumptions are corrected, the potential problem of UWB interference to GPS wireless phones disappears. (The first assumption alone leads Qualcomm to overstate the ranges at which UWB would potentially impact GPS wireless phones by as much as a factor of 50.) A revised analysis using the proposed UWB emission limits for the GPS band shows that required separation ranges to prevent degraded noise figures are nowhere near the 75 meters or more originally reported, but instead range from a few meters at most down to tens of centimeters. Current proposals for UWB device operations are safe and reasonable.

The Qualcomm tests were specifically designed to measure the level of UWB noise power that would cause the onset of performance degradation in GPS-enabled wireless phones in a noise-free environment. This was done by directly conducting UWB signals from a signal generator into a wireless phone GPS receiver. The power level of the UWB signal injected into the

¹ Qualcomm comments of January 11, 2002, page 17. Qualcomm assumes that UWB emissions will occur at the existing Part 15 limits of -41.3 dBm/MHz. All of the parties commenting in these proceedings have acknowledged that the existing Part 15 limits are not adequate to fully protect GPS operations. XtremeSpectrum has consistently proposed limiting UWB emissions in the GPS band significantly below current Part 15 levels and has recently proposed an even tighter set of limits - see XtremeSpectrum comments dated January 3, 2002

² Qualcomm comments of January 11, 2002, page 17. See also Qualcomm comments dated March 8, 2001 where Qualcomm proposes using correction factors for non-line of sight effects such as clutter and where Qualcomm presents results for non-line-of-sight propagation based on a propagation constant of $n=3.3$ (versus $n=2$ for free-space).

³ Qualcomm comments of January 11, 2002, page 13.

wireless phone was varied over a range that allowed Qualcomm to establish the level at which interference would occur, under worst case conditions.

XtremeSpectrum does not take issue with these measurements; indeed, we adopt them as the foundation of a revised analysis presented below. The measurements represent one component in a procedure that allows one to separately measure, understand, and apply (1) the effect of noise generated by UWB devices, (2) the effect of man-made and natural noise in the environment (i.e. RFI), and (3) the effect of propagation losses and distortion caused by the indoor surroundings. However, rather than considering each and adding them together, Qualcomm's analysis ignored propagation losses and RFI -- yet presented the results as if the tests represented a realistic and complete real-world view. In fact, the results represent a simplistic measurement of only a single factor affecting the performance of GPS receivers.

II. Revised analyses – Separation Distance Requirements

It is straightforward to use the same *measured* threshold results report by Qualcomm and apply them in the context of realistic proposals for UWB emission limits in the GPS bands. When this analysis is done, it shows that required separation ranges are as low as tens of centimeters.

Table 1 shows the results of such an analysis where the UWB emission levels in the GPS band are assumed to be limited as proposed by XtremeSpectrum. (These limits are 21 dB below Part 15 levels for non-peer-to-peer communications, and 34 dB below Part 15 levels for peer-to-peer communications.) The table shows that original separation ranges required for 50 or 150 meter position errors are reduced from the 9.2 to 14.5 meters reported by Qualcomm⁴ to only ***0.81 to 1.3 meters*** using the limit of 21 dB below Part 15. These ranges are even further reduced to only ***18 to 29 centimeters*** for the case of the peer-to-peer limit of 34 dB below Part 15.

UWB modulation	Unmodulated pulses	Dithered Pulses
Original reported separation for 50 meter error case ⁴	10.2 to 14.2 m	9.7 to 14.5 m
Original reported separation for 150 meter error case ⁴	9.2 to 12.1 m	9.2 to 13.0 m
Revised 50 meter case (-21 dB limit)	0.91 to 1.3 m	0.86 to 1.3 m
Revised 150 meter case (-21 dB limit)	0.81 to 1.1 m	0.82 to 1.2 m
Revised 50 meter case (-34 dB limit)	20 to 28 cm	19 to 29 cm
Revised 150 meter case (-34 dB limit)	18 to 24 cm	18 to 26 cm

Table 1: Analysis of separation ranges for UWB interference based on measured interference thresholds and proposed UWB emission limits for the GPS band.

⁴ These results are taken from Figures 4-4 through 4-9 and the accompanying text in Qualcomm's submission dated January 11, 2002.

The additional protection afforded by the proposed emission limits clearly make GPS interference ranges “off scale” on the low end.

III. The Relative Impact Of Other RF Signals In The Environment

The Qualcomm analysis assumes no other interference -- essentially, it assumes the wireless handset and UWB device are alone in the universe. But a GPS-enabled wireless phone in the vicinity of an operating UWB device is necessarily in the vicinity of digital devices or other unintentional emitters as well, even if only because UWB devices will be embedded in computers, PDAs, and other unintentional emitters. These are permitted to emit RF interference power in the GPS band of 100 to 2000 times greater than that of the UWB device (assuming proposed UWB limits of 21 dB and 34 dB below Part 15 levels). Under such conditions, the potential for interference from UWB devices is insignificant.

IV. Revised Analysis – Impact on Noise Floor

Qualcomm’s analysis made predictions about the effect of UWB emissions on the receiver noise floor for a GPS enabled wireless phones. Based on theoretical predictions, Qualcomm concluded that a UWB device operating at Part 15 levels could result in a 1 dB increase in the GPS receiver’s noise figure, with the UWB transmitter 75 or more meters away.⁵ But Qualcomm also presented empirical measurements of the noise figure degradation. The measurements show that the theoretical analysis was wrong; it predicted that the noise figure degraded by ½ to 1 dB too much. It takes a –10 dB I/N to degrade the noise figure by ½ dB, and it takes a –6 dB I/N to degrade the noise figure by 1 dB. So this error is not small. It means that the noise used in the theoretical analysis was 6 to 10 dB too low. This discrepancy is understood to simply account for the lack of real-world RFI environment being included in the analysis. The GPS receiver is not limited by its own internal noise, but by cross-correlation noise caused by other GPS satellites and other external RFI.⁶

Table 2 presents a revised analysis that simply changes the UWB emission from Part 15, to 21 dB and 34 dB below part 15. The predicted range of 75 meters based on the original theoretical analysis is reduced to 6.7 and 1.5 meters respectively. When the ½ to 1 dB adjustment is made to match empirical results, the ranges are reduce to approximately 5 meters and 1 meter, respectively, for the 21 and 34 dB lower limits.

⁵ This figure of 75 meters is reported in multiple places in the Qualcomm comments, notable in Figure 4-10, page 21.

⁶ Figure 4-19 on page 25 shows that empirical measurements of noise floor degradation are consistently ½ to 1 dB lower than the theoretical predictions.

	Theoretical Separation for Noise Figure Degradation	Empirical Separation for Noise Figure Degradation
Original result based on -41.3 dBm/MHz UWB	75 m	55 to 65 m
Revised based on 21 dB below Part 15	6.7 m	4.9 to 5.8 m
Revised based on 34 dB below Part 15	1.5 m	1.1 to 1.3 m

Table 2: Analysis of required separation ranges to produce 1 dB increase in receiver noise figure using proposed UWB emission limits for the GPS band.

It is important to note that even these revised results need to be viewed as conservative predictions because they do not reflect any *measured* degradation in actual GPS performance. The Qualcomm method of "wiring in" the UWB interference source omitted real-world effects such as the presence of other nearby interference sources. In practice, this typical background interference will have a much greater effect on indoor GPS performance than UWB emissions that are hundreds to thousands of times lower than existing Part 15 levels.

V. Summary

Comments submitted earlier in these proceedings claimed that GPS-based location services for E-911 would require as much as 20 dB more protection against potential UWB interference than does conventional GPS operation.⁷ The results of Qualcomm's laboratory measurements and the revised analysis above clearly demonstrate that this is not true; no additional protection is needed. Assisted-GPS based E-911 systems benefit from approximately 20 dB additional processing gain relative to conventional GPS. This processing gain is equivalent to reducing the effective bandwidth by a factor of 100 (20 dB). This bandwidth reduction adds 20 dB further protection against UWB emissions.⁸

Qualcomm has made specific quantitative measurements of degradation in Assisted GPS-enabled wireless phones. These threshold measurements, used in conjunction with the emission limits proposed by XtremeSpectrum for the GPS band, show that the required protection criterion for UWB-GPS separation established by the NTIA are also met for Assisted-GPS based E-911 systems using the same emission limits.⁹

⁷ See comments by U.S. GPS Industry Council, written *ex parte* presentation *Comments on XtremeSpectrum, Inc. "Emission Mask" Proposal to the FCC*, Appendix A, filed 21 June 2001 and U.S. GPS industry Council, *ex parte* presentation, *An Assessment of UWB Effects on GPS Receiving Equipment*, filed 22 May 2001.

⁸ See XtremeSpectrum comments dated July 25, 2001 containing analysis showing that GPS-based E-911 devices operate using increased processing gain and that attenuation of potential UWB interference to levels 20 dB or more below the receiver noise floor cannot possibly provide any improvements in GPS E-911 operation.

⁹ The most stringent interference requirements analyzed by the NTIA for UWB interference entailed operation of a UWB device only 2 meters from a conventional GPS receiver without interference (NTIA Special Publication 01-45, dated Feb 2001). Proposed emission limits by XtremeSpectrum are shown to more than satisfy these requirements in comments filed April 25, 2001.

Conclusion: When corrected for realistic assumptions, the Qualcomm test results demonstrate the proposed emission limits will provide protection to both present and future GPS systems.

APPENDIX -- Proposed Rule Text

15. ____ Protection of other services.

(a) An ultra-wideband communications device may not be mounted on an outdoor surface or support.

(b)(i) Under no circumstances may the emissions from an ultra-wideband communications device exceed these limits:

Frequency (MHz)	Field strength (microvolts/meter)	<i>[NOTE IN DRAFT]</i>
960-1574.92	125	<i>[Class B - 12 dB]</i>
1574.92-1575.92	45	<i>[Class B - 21 dB]</i>
1575.92-1990	125	<i>[Class B - 12 dB]</i>
above 1990	500	<i>[Class B]</i>

(ii) In the table above, the measurement distance is 3 meters. The tighter limit applies at band edges. Measurements shall be performed using a resolution bandwidth of 1 MHz.

(iii) In addition to the provisions of paragraph (b)(i), emissions limits in the band 1574.92-1575.92 MHz measured using a resolution bandwidth of 10 kHz shall not exceed 15 microvolts/meter measured at 3 meters. *[NOTE IN DRAFT: This represents a 10 dB additional attenuation for spectral lines in the GPS band.]*

(c) The provisions of this subsection apply to a battery-powered ultra-wideband device in communication with another battery-powered ultra-wideband device.

(i) The following emissions limits apply in lieu of those set out in section (b):

Frequency (MHz)	Field strength (microvolts/meter)	<i>[NOTE IN DRAFT]</i>
960-1610	10	<i>[Class B - 34 dB]</i>
1610-3100	80	<i>[Class B - 16 dB]</i>
3100-4200	160	<i>[Class B - 10 dB]</i>
above 4200	500	<i>[Class B]</i>

(ii) A battery-powered ultra-wideband device must be designed so that it cannot commence communicating with another battery-powered ultra-wideband device unless the user affirmatively initiates the transmission, as by pressing a button.

(iii) As an alternative to compliance with paragraphs (i) and (ii), a battery-powered ultra-wideband device can be made incapable of communicating with another battery-powered ultra-wideband device outdoors.

[NOTE IN DRAFT: The last provision allows "full power" peer-to-peer operation where the device can establish it is indoors -- e.g., by detecting a nearby AC-powered unit.]